Public healthcare expenditure and the COVID-19 pandemic: India

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Introduction

The Bhore Committee Report, 1946, a report by the Health Survey and Development Committee was a landmark report for India that laid down the principle that access to primary care is a basic right and should be independent of individual socioeconomic condition. Quality of healthcare has various dimensions like adequate access, administrative efficiency, equity, health outcomes, etc.

While there have been significant improvements in the Indian health sector- mortality rates fell from 90.9 deaths per 1000 live births in 1990 to 28.3 in 2019 and life expectancy increased from 57.875 years in 1990 to 69.656 years in 2019 (World Bank), there is still a lot of scope for improvement. For instance, there is a shortage of skilled manpower in the health sector. The doctor-to-patient ratio is very low, which is 0.7 doctors per 1,000 people as compared to a world average of 2.5 per 1,000. On top of that, absenteeism rates are high. The national average absence rate of medical providers in Public Health Centers (PHCs) and Community Health Centers (CHCs) was 39%, with the absence rate for doctors exceeding 43 percent according to data from a nationally representative all-India survey (conducted in 2003) of over 1400 public health centers across 19 major states. (Karthik Muralidharan et al, 2011). There is a lack of sufficient infrastructure. Datar, Mukherji, and Sood, (2007) found that in 2005 there were significant shortfalls at each level of health facility: There were 10 percent and 50 percent fewer Sub-centers (SCs) and PHCs respectively than needed and 50 percent fewer CHCs than the required level.

There is also a huge inter-state disparity in healthcare outcomes. Health outcomes of a few states are almost at par with those in some upper-middle-income and high-income countries (for example, the Neonatal Mortality Rate (NMR) in Kerala is similar to that of Brazil or Argentina), while some other States have health outcomes similar to that in the poorest countries in the world (for example, NMR in Odisha is close to that of Sierra Leone). The Health Index score (a composite score taking into consideration 23 key indicators which cover important aspects of the performance of the health sector) calculated by NITI Aayog for 2017-18 highlights this inter-state disparity. The overall Health Index Score for the best-performing state (Kerala- 74.1) is more than 2 and a half times more than that of the worst-performing state (Uttar Pradesh- 28.61).

The COVID-19 pandemic put a lot of pressure on the already fragile healthcare system of India and its impact and severity[1] was disproportionate across States. For instance, states such as Maharashtra, Delhi, Chennai along with Punjab and Karnataka bore the maximum load of the pandemic and fell short of health infrastructure and equipment ranging from oxygen to ventilators.

There are many factors which affected the severity of COVID-19 region-wise. These include connectivity to the outside world, population density, demographic factors, availability of healthcare resources and accessibility to those resources, etc. The main focus of this research will be to see whether or not pre-COVID-19 access to quality healthcare had any impact on the severity of COVID in different states and Union territories of India.

[1] Severity can be measured by caseload per million, case fatality rate, number of hospitalizations, etc.

Literature Review

Access to healthcare

Access to good quality healthcare is very important to ensure well-being of people. Good Health ensures that people have a good quality of life and economic well-being. Additionally, it improves consumption and production in the short run and in the long run, it improves the returns from investments in productive activities (Somi et al, 2009)

Institute of Medicine (US) on Monitoring Access to Personal Health Care Services (1993) defined access as "the timely use of personal health services to achieve the best health outcomes. Several indicators can be considered to measure access to healthcare. Schneider et al (2017) measured access to healthcare in the USA by taking into account affordability and timeliness. Ursulica (2016) measured access to healthcare by using temporal and spatial indicators. Spatial accessibility was measured taking into account the average distance a patient has to cover to reach the nearest medical unit and temporal accessibility taking into account the travel time of the patient to reach the nearest medical unit. Burger and Christian (2020) considered 3 dimensions of access-availability, affordability, and acceptability to measure healthcare access in post-apartheid Africa. Availability captured whether suitable facilities are provided when and where they are needed and what the quality of the service people get. Affordability captured the cost of using the healthcare facilities, ability and willingness of people to pay, financing arrangements for healthcare. Finally, the acceptability indicator captured the attitudes and behavior of healthcare provider and their client responsiveness. Barriers to access to health care may increase the risk of poor health care outcomes. For instance, if there are physician shortages, people may have to wait for a longer duration of time and get delayed care. If there is a lack of geographical accessibility to hospitals, people may not make it in time in case of emergencies.

Various studies have revealed a positive relationship access to healthcare and health outcomes. Mackinko et al (2007) found that an increase in one primary care physician per 10,000 population was associated with an average mortality reduction of 5.3%. Rosano et al (2013) conducted a systematic review of 51 studies to check the association between PHC accessibility and avoidable hospitalizations. Most studies show that in areas with greater access to Primary Health Centers had lower hospitalization rates in ambulatory care sensitive conditions (ACSC)[2]. Access to healthcare plays a very crucial role for people and can help in the prevention of diseases and disability, detect illnesses, increase life expectancy, reduce the probability of premature death, etc.

Public Expenditure as a determinant of Health Outcomes

Investment in health care infrastructure and workforce is expected to improve the health conditions of the population at a macro level. Several studies have been done to assess the impact of health care expenditure on health outcomes.

Rahman et al (2018), used World Bank data set for 15 countries from the SAARC-ASEAN region for 20 years (1995-2014). They determined the effects of healthcare expenditure on health outcomes using fixed and random effect models. The health outcomes indicators that were chosen were life expectancy at birth (measured as the average life expectancy of the male and female population in years), infant mortality (measured per 1,000 live births), and death rate (measured as crude death rate per 1,000 people). These variables were chosen because their status is these countries is relatively poor in countries in this region. Health expenditure was found to improve

[2] "Ambulatory Care Sensitive Conditions (ACSCs) are health conditions-diagnoses for which timely and effective outpatient care can help to reduce the risks of hospitalization by either preventing the onset of an illness or condition, controlling an acute episodic illness or condition, or managing a chronic disease" (Billings et al, 1993).

the health status of the population in the region. Total (public and private) health expenditure was found to have a significant effect on reducing infant mortality rates. Private health expenditure played a significant role in reducing the crude death rate. Improved sanitation facilities and increased per capita incomes also had a positive impact on improving the health of the population in that region. Another study was done for 44 countries in sub-Saharan Africa from 1995-2010 to analyze the impact of health care expenditures on health outcomes. There were improvements in life expectancy at birth, reduction in death and infant mortality with increased health care expenditure. Public and private spending exhibit a strong positive association with outcomes but public spending has a relatively higher impact (Novignon et al, 2012). Public expenditure is a major determinant of health status (life expectancy, infant mortality rate, under-five mortality rate) in Lesotho, along with availability of physicians, female literacy, and child immunization (Akinkugbe & Mohanoe, 2009).

On the other hand, a study by Filmer & Pritchett (1999) found that public spending on health had no impact in determining child and infant mortality. They used cross-national data to measure the impact of public spending on health and non-health factors in determining child and infant mortality. 95% of the cross-national variation in mortality could be explained by per capita income in the country, inequality of income distribution, the extent of female education, ethnic fragmentation, and the predominant religion.

Health care expenditure is only a necessary not sufficient condition for progress in population health. A major factor that affects health outcomes is whether the allocation of resources is effective and efficient (Novignon et al, 2012).

In India, current health expenditure is incurred on inpatient and outpatient care delivery, pharmaceuticals and medicines. This is largely received by private sector healthcare providers and is mostly financed by households from their own pockets. In India, Public health expenditure per capita in India is just ₹1,765. There is a lot of disparity in per capita healthcare expenditure by States. States which perform poorly on healthcare spending are mostly funded by out-of-pocket expenditure (Uttar Pradesh, Bihar, West Bengal, Jharkhand, Madhya Pradesh, Odisha). There States are also characterized by weak primary healthcare systems. Alternatively, States with higher public healthcare spending have less out-of-pocket expenditure (Himachal Pradesh, Haryana, Karnataka, Maharashtra). These States spend more than the national average, i.e., from Rs. 3500 to 10,000. These are also the States with better primary Healthcare facilities; more doctors per lakh population and fewer lesser people per PHC. Kerala is an exception with both higher-than-average government spending and out-of-pocket spending. Kerala was able to use this in handling the Nipah outbreak as well as the first wave of COVID-19 (Duggal, 2020 & RBI, 2020).

Reliance on private hospitals for hospitalizations and its affordability also differs across Indian States. Uttar Pradesh, Bihar, Punjab and Andra Pradesh have a higher reliance on private hospitals the cost of hospitalization in these states is higher than the India average. This is responsible for crowding out medical access to the poor in these States. Himachal Pradesh, Kerala, Goa, Tamil Nadu and Delhi have lower reliance on private hospitals and are relatively affordable (RBI, 2020). There are “Two Indias”- Northern states with lower quality and high per-visit costs and Southern states with high quality and lower per-visit costs (Das, 2020).

Healthcare human resources play a very crucial role in health care delivery. There are significant state-level differences even in this area. Leaving Telangana, Southern States have a significantly better medical doctors' coverage in comparison to Uttar Pradesh and Bihar with abysmally low number of doctors and nurses with respect to their population size. In terms of knowledge, the average provider knowledge in Tamil Nadu and Kerala is over 2 standard deviations higher than Bihar and Uttar Pradesh (Das, 2020) Another issue is absenteeism among health providers. An all-India survey of about 1400 public health care centers across 19 major states revealed that on average, 40% of doctors and medical service providers were absent from work on a typical day. Absenteeism rates ranging between 30% in Madhya Pradesh to 67% in Bihar. At remote facilities with poor infrastructure, doctors were absent at significantly higher rates (Muralidharan, 2011).

And even when doctors and nurses are present, they don’t work so well. Das and Hammer sat with providers all day and recorded their interactions- Referrals were rarely given- less than 7% of the time, patients were given instructions only half the time and only one-third of the doctors offered any guidance on the follow-up. This is worse in the public sector than the private sector. Public providers ask fewer questions, and mostly just asked patients for their diagnosis and prescribe medicine on the basis of that diagnosis.

Thus, we can see that inter-state disparities exist in the access and affordability of health care. Government expenditure plays a huge role in financing healthcare in India. The private sector, despite being expensive has a predominant share reflecting that people turn to it due to quality and accessibility concerns. There are, therefore, high out-of-pocket expenses. This raises problems related to healthcare access and equity which has been a huge issue in the context of COVID-19 and the vulnerability of low-income segments of society.

Another critical variable is hospital infrastructure (number of government beds available per 10,000 people). Himachal Pradesh and Delhi are best placed in this category with Bihar and Jharkhand lagging.

COVID-19: India

"Coronavirus disease is an infectious disease that is caused by the SARS-CoV-2 virus." The majority of people infected by the virus experience mild to moderate illness (symptoms like headache, nausea, cough, tiredness) and can recover without any treatment. However, the illness can also be severe (symptoms like shortness of breath, loss of speech and mobility, and chest pain) and people, in that case, need medical attention. People more prone to this disease are older people with underlying conditions like diabetes, cancer, respiratory and cardiovascular disease. In the most severe cases, people can die due to the coronavirus. The virus spreads through the nose/ mouth of the infected person (WHO).

The first confirmed case of the COVID-19 infection was detected in Kerala on January 27, 2020. By March 24, which was the day of the first national lockdown, there were a total of 567 people infected by it; it had spread to 15 states and union territories. By October 12, 2020, except for Lakshadweep islands, the infection had spread to all states and UTs affecting 71.2 lakh people. 51.2% of all cases were found in Maharashtra, Andra Pradesh, Karnataka, and West Bengal, and 18.7% in Kerala, Uttar Pradesh, and West Bengal. Cases in the first wave peaked on September 16, 2020, after which there was a decline in the number of new cases in the subsequent weeks.

During the pandemic, there were shortages of the needed manpower and medical infrastructure. Patients were unable to get ambulances and even the best-equipped hospitals ran out of oxygen. For instance, in the Basi village- 1.5km away from Delhi- most deaths were caused by a lack of oxygen. There was a shortage of medical facilities and doctors. The sick were rushed to the closest district hospital which was 4 hours away and most people did not make it in time (Sen et al, 2021). This is just one example. Around the country, we were grappling with shortages in infrastructure and manpower.

The impact of COVID in Indian states has been very disproportionate. For instance, as of March 29, 2021- Of the total cases reported in India, five states (Maharashtra, Kerala, Tamil Nadu, Karnataka, and Tamil Nadu) contributed to more than 54% of the total cases. In the last week of March 2021, India reported 1876 deaths with the highest deaths in Maharashtra (782), then Punjab (366), and Chhattisgarh (126). Punjab had the highest case fatality ratio (2.9%)[3]. In May 2021- when the cases peaked in India the case fatality ratio was 1.17% It was ranging from 1.85% in Maharashtra to 2.54% in Delhi. The six worst-hit States were Delhi, Uttarakhand, Punjab, Maharashtra, Jharkhand, Goa (WHO, 2021).

Research Gap

The COVID-19 pandemic has resulted in a substantial loss in human life. And has posed various challenges for public health. Millions of people are at the risk of falling into poverty and those who are undernourished are expected to increase by 132 million at the end of 2021. The impact has been devastating.

In the case of India- First, there are a lot of state-wise differences in quality of health care delivery, public health expenditure, infrastructure, and manpower. Second, the impact of the covid-19 state has been disproportionate in different Indian states- some States were better able to handle

[3] Figure 2 in the Appendix shows the case fatality rates in different States as October 13, 2021.

the situation than others. A greater understanding of what were the factors that enabled some States to mitigate the effects of the COVID-19 pandemic will enable India to be better prepared for such situations. The fact that such pandemics are expected to occurrences have more likely today due to globalization, climate change, health worker shortages, etc. (Gavi, 2020), makes such an analysis an urgent matter.

Research Objective

Wide variation in state level spending on healthcare prior to 2020 leads us to ask the question whether historically better funded states achieved lesser mortality by covid-19. The objective of this research will be to investigate whether pre-covid public healthcare expenditure had any impact on the severity of the COVID-19 pandemic in the 20 largest Indian States (Appendix).

Data and Variables

Dependent variable:

Case fatality rate (CFR)

$$CFR = \frac{Number\ of\ deaths}{Total\ number\ of\ confirmed\ cases} \qquad -(1)$$

The covid-19 pandemic in India occurred in three prominent waves[4]:

Wave	Start date	End data
I	30 Jan, 2020	31 December, 2020
II	1 Feb, 2021	30 September, 2021
III	1 October, 2021	2 April, 2022

Independent variables:

a. Per-capita public health expenditure (Capital + Revenue) (pche)

Source: RBI, EPRFW

b. Gross State Domestic Product (GSDP)

Source: CMIE (2010,2011,2012, 2020)

c. Population density[5]:

Description- Population per square feet

Source: Handbook of Statistics on Indian States, 2020-21 (Reserve Bank of India)

d. Proportion of population above the age of 60 (Aged population)

Source: CMIE (2010,2011,2012, 2020)

[4] While there is no official definition of what constitutes a wave in a pandemic, it is generally used to define the rising and declining trends of infections over a period (Deccan herald, 2021). The start and end date of waves are approximate and have been estimated after observing the trend in total confirmed cases in India

[5] Population density is only available for census years, therefore, values for other years have been calculated by assuming a constant growth rate

Based on previous literature, health care expenditure is expected to lead to better healthcare outcomes. The study has included control variables which could have had an impact on the case fatality ratio. Covid-19 is a communicable disease and spreads from an infected person's mouth or nose in small liquid particles, a state with higher population density is expected to be more susceptible to covid-19, therefore, population density is included as an independent variable.

According to Centre for Disease Control and Prevention, older adults are more likely to be hospitalized or die from covid-19. Therefore, the variable 'proportion of population above the age of 60' is considered to check whether or not states with higher proportion of old population had a higher case fatality rate.

Gross State Domestic Product is expected to have a negative relationship with adverse health outcomes. Theoretically, countries with higher GDP have better public health programs, and generally, better living standards. This may make them better placed to prevent and treat diseases.

Methodology

The analysis is state-level and the period of study is 2007-2021. Panel data estimation methods—fixed effect and random effects are used to assess the relationship of public healthcare expenditure and COVID-19 CFR.

Eleven-period moving averages are calculated for independent variables for the time periods 2007-2017, 2008-2018, 2009-2019. A panel of three periods and four variables is created for twenty states.

Model A:

$$CFR = \alpha + \beta_1 pche + \beta_2 gsdp + \beta_3 agedpopulation + \beta_4 populationdensity + \gamma_2 S_2 + \cdots + \gamma_n S_{19} + \delta_2 T_2 + \delta_3 T_3 \qquad -(2)$$

$\beta_n - coefficients\ of\ independent\ variables$

$S_n - binary\ variable\ that\ represents\ entities\ (states)$

$\gamma_2\ - coeffient\ for\ binary\ regressors\ (entities)$

$T_t - binary\ variable\ for\ time$

$\delta_n - coefficient\ for\ binary\ regressors\ (time)$

Various studies have shown evidence that the deaths reported due to covid-19 were under-reported. According to Shewade et al (2021), The estimated COVID-19 deaths in India after adjusting for the coverage and quality of the routine death surveillance may be 5.5–11 times the reported COVID-19 deaths. The findings of project “Jeevan Raksha” indicate that there has been massive underreporting of deaths linked to the pandemic – Gujrat (5722%) followed by Rajasthan (473%), Jharkhand (464%) and Uttar Pradesh (228%).

Death surveillance coverage is death registration along with medical certification of cause of death (MCCD). According to Shewade et al (2021), In India, routine death surveillance coverage in India is 18.1%. Low death surveillance coverage and errors in MCCD have contributed to underreporting of deaths. In addition to that covid-19 death reporting focused only on deaths among reported cases and the case detection ratio itself has been low. To take into account the factors mentioned, they calculated a correction factor at national and state level for India to find an estimate of covid-19 mortality.

Model B incorporates this correction factor (Figure 3, Appendix)[6]. The case fatality ratio (dependent variable) has been calculated as specified below

$$CFR_{corrected} = \frac{Number\ of\ deaths \times Correction\ factor}{Total\ number\ of\ confirmed\ cases} \qquad -(3)$$

Model B:

$$CFR_{corrected} = \alpha + \beta_1 pche + \beta_2 gsdp + \beta_3 agedpopulation + \beta_4 population\ density + \gamma_2 S_2 + \cdots + \gamma_n S_{19} + \delta_2 T_2 + \delta_3 T_3 \qquad -(4)$$

[6] This correction factor was calculated as on July 31, 2020. This is assumed to be applicable to the entire period of the pandemic until today. A similar correction factor was not calculated for confirmed cases.

Results

Model A:

To check whether fixed effect or random effects is more appropriate for the model, the Hausman test (Figure 4, Appendix) is used. Prob>chi2 is greater than 0.05, therefore, the random effects model is more appropriate to interpret the relationship between the independent and dependent variables

VARIABLES	(1) Fixed Effects Model A	(2) Random Effects Model A
pche	0.00003322	0.000001
	(0.00010534)	(0.000040)
GSDP	-0.00000007**	0.000000
	(0.00000003)	(0.000000)
Population density	-0.00043478	0.000008
	(0.00101128)	(0.000042)
Aged population	0.31136251	0.097774*
	(1.02210471)	(0.052118)
Constant	1.92375335	0.491716
	(7.83824368)	(0.459027)
Observations	60	60
R-squared	0.64308345	
Number of state	20	20
State FE	YES	
Year dummies	YES	YES

In the fixed effects model, the coefficient of GSDP is significant at 5% level of significance. The sign of the coefficient is as expected. On an average, a one unit increase in GSDP reduces case fatality rate by 7.00E-08%. Coefficients of per capita public healthcare expenditure, population density and aged population are insignificant. In the random effects model, none of the independent variables seem to have an impact on case fatality rate.

Model B:

To check whether fixed effect or random effects is more appropriate for the model, the Hausman test (Figure 5, Appendix) is used. Prob>chi2 is lesser than 0.05, therefore, the fixed effects model is more appropriate to interpret the relationship between the independent and dependent variables.

Regression results:

VARIABLES	(1) Fixed Effects Model B	(2) Random Effects Model B
pche	-0.000175***	0.000013
	(0.000042)	(0.000013)
GSDP	-0.000000	-0.000000
	(0.000000)	(0.000000)
Population density	0.000228	-0.000006
	(0.000359)	(0.000014)
Aged population	0.030491	-0.008703
	(0.124649)	(0.017156)
Constant	-0.011120	0.213994
	(1.204876)	(0.149334)
Observations	60	60
R-squared	0.364030	
Number of states	20	20
State FE	YES	
Year dummies	YES	YES

Random effects model yields no significant relationship between the independent and dependent variables. However, as mentioned above, the interpreting the fixed effects model is more appropriate for this regression model. Based on the fixed effects model controlling for time, per capita public healthcare expenditure is significant at 5% level of significance. On an average, an increase in health care expenditure by Rs. 10,000, will decrease case fatality rate by 1.75%. Robust standard errors were calculated to control for heteroskedasticity.

Coefficients of GSDP, population density and aged population are insignificant.

Conclusion

Previous literature has had mixed results about the impact of health care expenditure on health outcomes. As mentioned above, Filmer & Pritchett (1999) found that public spending on health had no impact in determining child and infant mortality, But the point they were trying to make was this- public health expenditure has a lot of potential to reduce mortality but there is a mismatch between the potential and what actually happens. Three things that must happen for public spending to improve health outcomes cheaply are- the creation of effective health services, change in the total amount of effective health services consumed by the population, and these additional services must be cost-effective.

The results from this study shows that higher per capita public health expenditure can reduce the severity of COVID-19. Although, there are numerous factors which affect the impact of covid-19 like demographic factors, availability of healthcare resources and accessibility to those resources, measures taken by the government to control the spread of the disease, how effectively those measures are implemented and monitored, etc., health care capacity can play a major role in mitigating the health impacts of COVID-19.

This research also brings to light the importance of accurate data collection and how it can impact policy decisions. Underreporting of covid-19 deaths and cases poses a challenge in analyzing its epidemiological characteristics. In absence of accurate estimates, proportion of severe and critical cases and mortality rate are difficult to calculate. A true picture of mortality rates can help in eliciting a better public health response to tackle the pandemic.

References

Akinkugbe, O., & Mohanoe, M., (2009). Public Health Expenditure as a Determinant of Health Status in Lesotho. *Social Work in Public Health, 24(1-2*), 131-147. https://doi.org/10.1080/19371910802569716

Arakal A. R. (2021), Study claims underreporting of Covid-19 deaths in most states, 'worst in Gujarat, Rajasthan since July'. *Indian Express.* https://indianexpress.com/article/cities/bangalore/study-underreporting-covid-19-deaths-states-gujarat-rajasthan-july-7580344/

Banerjee, A, V., and Duflo, E. (2011). Low Hanging Fruit for Better (Global) Health? (pp 61-105), Poor Economics. New York, NY: Public Affairs.

Billings J., Zeitel L., Lukomnik J., Carey T. S., Blank A. E., & Newman L. (1993). Impact of socioeconomic status on hospital use in New York City. Health Aff (Millwood), *12(1)*, 162-73. https://doi.org/10.1377/hlthaff.12.1.162

Burger, R., & Christian, C. (2020). Access to health care in post-apartheid South Africa: Availability, affordability, acceptability. *Health Economics, Policy and Law,15(1)*, 43-55. https://doi.org/10.1017/s1744133118000300

Chokshi, M., Patil, B., Khanna, R., Neogi, S. B., Sharma, J., Paul, V. K., & Zodpey, S. (2016). Health systems in India. *Journal of perinatology: official journal of the California Perinatal Association*, *36*(s3), S9–S12. https://doi.org/10.1038/jp.2016.184

Das J. (2020). Two Indias: The structure of primary health care markets in rural Indian villages with implications for policy. *Social Science & Medicine*. https://doi.org/10.1016/j.socscimed.2020.112799

Datar A., Mukherji A., & Sood N. (2007). Health infrastructure & immunization coverage in rural India. *Indian Journal of Medical Research*, *125(1)*, 31-42. https://journals.lww.com/ijmr/pages/default.aspx

Deccan herald (2021*), Explained | What's a wave in a pandemic?* https://www.deccanherald.com/national/explained-what-s-a-wave-in-a-pandemic-987904.html

Duggal, R. (2020, June 3). *States that spend more on healthcare less affected by Covid impact.* Hindu Business Line. https://www.thehindubusinessline.com/opinion/states- that-spend-more-on-healthcare-less-affected-by-covid/article31738995.ece

Filmer, D., & Pritchett, L. (1999). The impact of public spending on health: does money matter? *Social Science & Medicine*, *49*, 1309-1323. https://doi.org/10.1016/S0277-9536(99)00489-X

Healthy People.gov (2020). Access to Health Services. Office of Disease Prevention and Health Promotion. https://www.healthypeople.gov/2020/leading-health-indicators/2020-lhi-topics/Access-to-Health-Services

Institute of Medicine (US) Committee on Monitoring Access to Personal Health Care Services. (1993). Access to Healthcare in America. *National Academies Press (US).* https://www.ncbi.nlm.nih.gov/books/NBK235882/

Macinko J., Starfield B., & Shi L. (2007). Quantifying the health benefits of primary care physician supply in the United States. *International Journal of Health Services, 37(1)*,111-126. https://www.jhsph.edu/research/centers-and-institutes/johns-hopkins-primary-care-policy-center/Publications_PDFs/2007_IJHS_Macinko.pdf

Ministry of Health and Family Welfare. (2020). *Rural Health Statistics.* https://hmis.nhp.gov.in/downloadfile?filepath=publications/Rural-Health-Statistics/RHS%202019-20.pdf

Muralidharan, K., Chaudhary, N., Hammer, J., Kremer, M., & Rogers, H. (2011). Is there a Doctor in the House? Medical Worker absence in India. *Harvard Scholar*. *https://econweb.ucsd.edu/~kamurali/papers/Working%20Papers/Is%20There%20a%20Doctor%20in%20the%20House%20-%2012%20April,%202011.pdf*

National Center for Diseases Control. (2021). *State-wise CFR map* [Map]. https://ncdc.gov.in/Mortality/CFR.html

Niti Aayog, Ministry of Health and Family Welfare & World Bank (2019), *Healthy States, Progressive India- Report on the Ranks on States and Union territories*. http://social.niti.gov.in/uploads/sample/health_index_report.pdf

Novignon, J., Olakojo, S.A., & Nonvignon, J. (2012). The effects of public and private health care expenditure on health status in sub-Saharan Africa: new evidence from panel data analysis. *Health Econ Review*, *2***,** 22. https://doi.org/10.1186/2191-1991-2-22

Rahman, M.M., Khanam, R., & Rahman, M. (2018), Health care expenditure and health outcome nexus: new evidence from the SAARC-ASEAN region. *Globalization & Health*, *14***,** 113. https://doi.org/10.1186/s12992-018-0430-1

Rampal. N. (2021, June 9). *Virus Curve dives below 2020 peak after 9 weeks.* Mint. https://www.livemint.com/news/india/virus-curve-dives-below-2020-peak-after-nine-weeks-11623178124899.html

Reserve Bank of India. (2020, October 27). *State Finances: A Study of Budgets* [Press release]. https://www.rbi.org.in/Scripts/BS_PressReleaseDisplay.aspx?prid=50573

Rosano A., Loha C. A., Falvo R., van der Zee J., Ricciardi W., Guasticchi G., & de Belvis A. G. (2013). The relationship between avoidable hospitalization and accessibility to primary care: a systematic review. *European Journal Public Health*, *23 (3)*356-360. https://doi.org/10.1093/eurpub/cks053

Somi, M. F., Bulter, J. R. G., Vahid, B., Abdullah, S., & Njau, J. D. (2009). Household responses to health risks and shocks: a study from rural Tanzania raise some methodological issues. *Journal of International Development*, *21(2)*, pages 200-211. https://doi.org/10.1002/jid.1555

Schneider, E.C., Sarnak, D.O., Squires, D.A., Shah, A., & Doty, M.M. (2017). Mirror, Mirror 2017: International Comparison Reflects Flaws and Opportunities for Better U.S. Health Care. *Commonwealth Fund*. https://www.commonwealthfund.org/publications/fund-reports/2017/jul/mirror-mirror-2017-international-comparison-reflects-flaws-and

Sen, S. R., Pradhan, B., Srivastava, S., & Pollard, R. (2021, May 19). *Entire Families' Wiped Out by Covid's Carnage in Rural India.* https://www.bloombergquint.com/coronavirus-outbreak/-entire-families-wiped-out-by-covid-19-s-carnage-in-rural-india

Sheel, A. (2021). The Indian Economy: Covid-19 and Beyond. *Economic and Political weekly, 56(21)*, https://www.epw.in/journal/2021/21

Shewade. D. H., Parameswaran G. G., Mazumder A., Gupta M. (2021), Adjusting Reported COVID_19 Deaths for prevailing Routine Death Surveillance in India. *Frontiers in Public Health.* https://doi.org/10.3389/fpubh.2021.641991

Ursulica, T. E. (2016). The Relationship between Health Care Needs and Accessibility to Health Care Services in Botosani County- Romania. *Procedia Environmental Sciences*, *32*, 300-310, ISSN 1878-0296. https://doi.org/10.1016/j.proenv.2016.03.035.

Verma A. (Host). (2021, May 16). Understanding Indian Healthcare (No. 225) [Audio podcast episode]. *Seen and the Unseen*. https://seenunseen.in/episodes/2021/5/16/episode-225-understanding-indian-healthcare/

WHO (2021), *India Situation Report*. https://www.who.int/india/emergencies/coronavirus-disease-(covid-19)/india-situation-report

Appendix

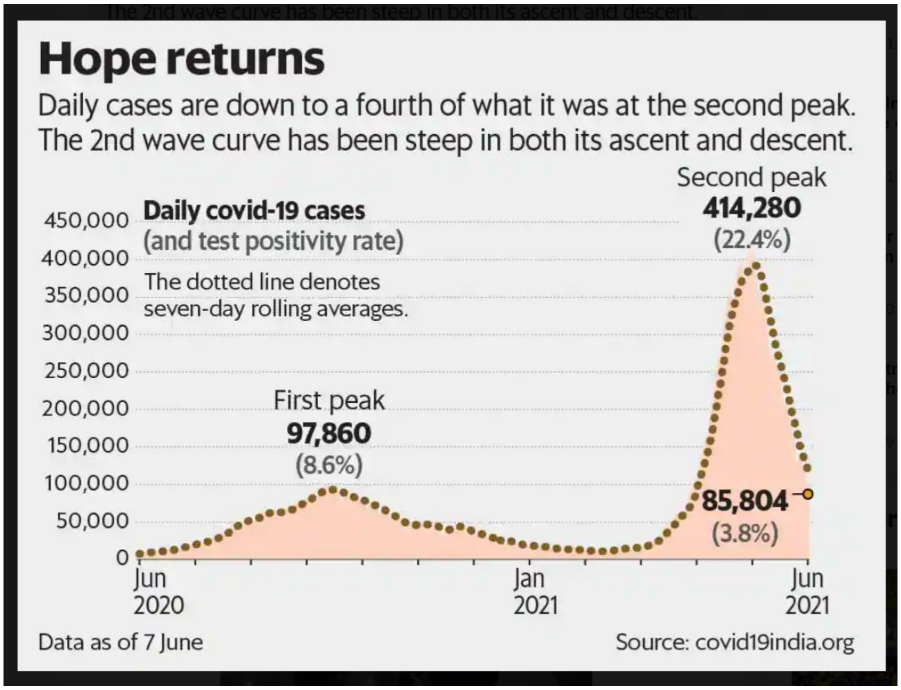
Table 1:

States
Andhra Pradesh[7]
Assam
Bihar
Chhattisgarh
Gujarat
Himachal Pradesh
Haryana
Jharkhand
Jammu and Kashmir
Karnataka
Kerala
Maharashtra
Madhya Pradesh
Odisha
Punjab
Rajasthan
Tamil Nadu
Uttar Pradesh
Uttarakhand
West Bengal

Note: List of States for which this study is conducted

[7] The state of Andhra Pradesh for the period of study is defined according to geographical boundaries in 2007. After 2014, when the state of Telangana was created, values for Andhra Pradesh have been calculated by adding the values for Andhra Pradesh and Telangana.

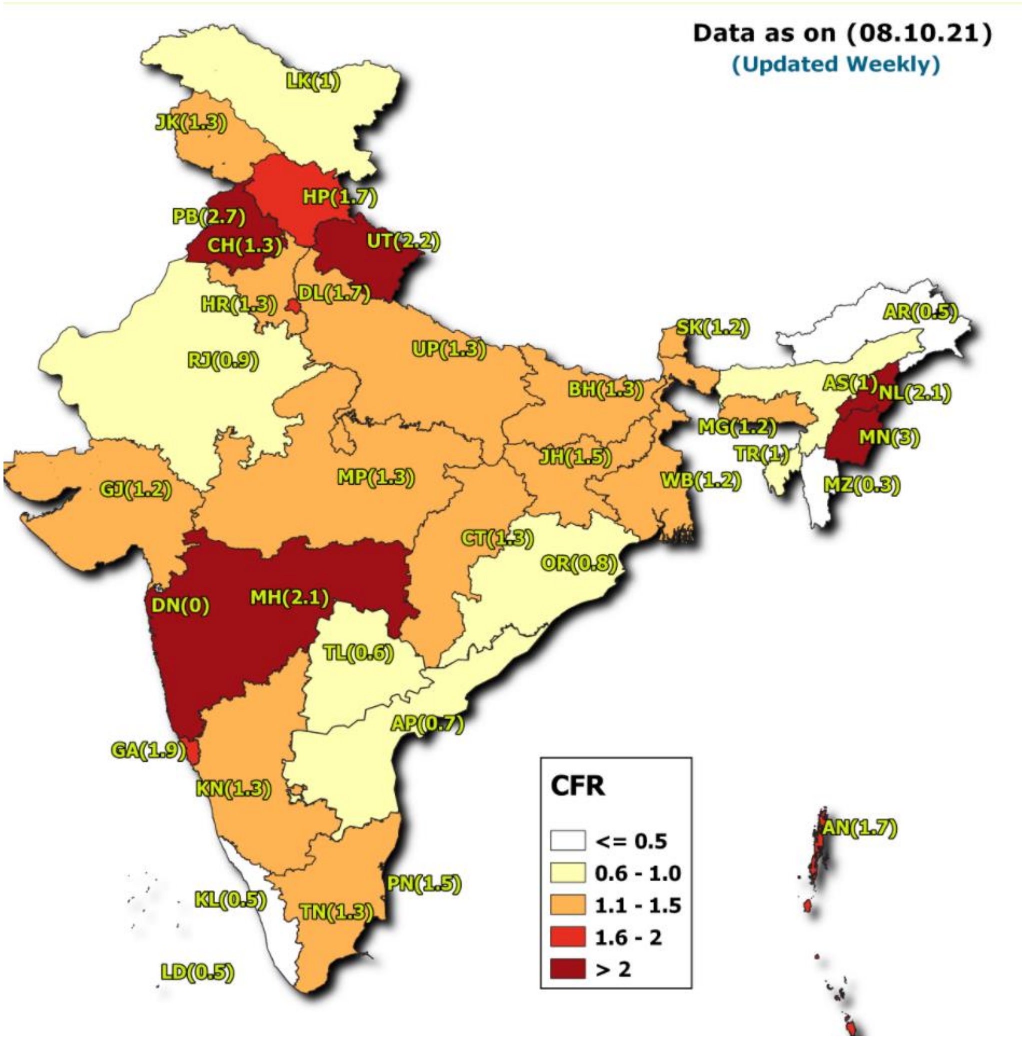
Figure 1



From *“Virus Curve dives below 2020 peak after 9 weeks,”* by Rampal N. (2021, June 9). Mint.

https://www.livemint.com/news/india/virus-curve-dives-below-2020-peak-after-nine-weeks-11623178124899.html

Figure 2



Note: The map shows the State-wise Case Fatality Rate due to Covid-19 as of October 13, 2021.

From National Center for Diseases Control. (2021). *State-wise CFR map* [Map].

https://ncdc.gov.in/Mortality/CFR.html

Figure 3

S. No.	States	Death registration among estimated deaths	MCCD among registered deaths	Death registration along with MCCD	Correction (multiplication) factor to adjust for routine death surveillance	Range of combined correction (multiplication) factor to adjust for routine death surveillance and errors in MCCD
		A	B	C = A*B	D = 1/(C)	Lower range = D*1, Upper range = D*2
1.	Andhra Pradesh	1.000	0.149	0.149	6.7	6.7, 13.4
2.	Telangana	0.582	0.374	0.218	4.6	4.6, 9.2
3.	Arunachal Pradesh	0.478	0.329	0.157	6.4	6.4, 12.8
4.	Assam	0.669	0.120	0.080	12.5	12.5, 25.0
5.	Bihar	0.346	0.136	0.047	21.3	21.3, 42.6
6.	Chhattisgarh	0.835	0.198	0.165	6.1	6.1, 12.2
7.	Goa	1.000	1.000	1.000	1.0	1.0, 2.0
8.	Gujarat	1.000	0.234	0.234	4.3	4.3, 8.6
9.	Haryana	1.000	0.204	0.204	4.9	4.9, 9.8
10.	Himachal Pradesh	0.839	0.150	0.126	8.0	8.0, 16.0
11.	Jharkhand	0.549	0.046	0.025	39.6	39.6, 79.2
12.	Karnataka	1.000	0.311	0.311	3.2	3.2, 6.4
13.	Kerala	1.000	0.119	0.119	8.4	8.4, 16.8
14.	Madhya Pradesh	0.788	0.105	0.083	12.1	12.1, 24.2
15.	Maharashtra	0.984	0.348	0.342	2.9	2.9, 5.8
16.	Manipur	0.375	0.514	0.193	5.2	5.2, 10.4
17.	Meghalaya	0.897	0.431	0.387	2.6	2.6, 5.2
18.	Mizoram	1.000	0.589	0.589	1.7	1.7, 3.4
19.	Nagaland	0.097	0.287	0.028	35.9	35.9, 71.8
20.	Odisha	1.000	0.111	0.111	9.0	9.0, 18.0
21.	Punjab	1.000	0.171	0.171	5.9	5.9, 11.8
22.	Rajasthan	0.999	0.131	0.131	7.6	7.6, 15.2
23.	Sikkim	1.000	0.425	0.425	2.4	2.4, 4.8
24.	Tamil Nadu	1.000	0.450	0.450	2.2	2.2, 4.4
25.	Tripura	1.000	0.223	0.223	4.5	4.5, 9.0
26.	Uttarakhand	0.707	0.111	0.078	12.7	12.7, 25.4
27.	Uttar Pradesh	0.608	0.051	0.031	32.3	32.3, 64.6
28.	West Bengal	0.918	0.129	0.118	8.4	8.4, 16.8
29.	Andaman and Nicobar	0.729	0.595	0.434	2.3	2.3, 4.6
30.	Chandigarh	1.000	0.718	0.718	1.4	1.4, 2.8
31.	Delhi	1.000	0.623	0.623	1.6	1.6, 3.2
32.	Puducherry	1.000	0.740	0.740	1.4	1.4, 2.8
33.	J&K and Ladakh	0.633	–	0.633	1.6	1.6, 3.2
34.	DNH, D&D	0.857	1.000	0.857	1.2	1.2, 2.4
35.	**India**	**0.860**	**0.210**	**0.181**	**5.5**	**5.5, 11**

MCCD, medical certification of cause of death; J and K, Jammu and Kashmir; DNH, Dadra Nagar Haveli; D and D, Daman and Diu.

**The correction factor to adjust for the prevailing routine death surveillance may be multiplied with a correction factor for errors in MCCD (we have considered an upper limit of two) to get the combined correction factor to adjust for the prevailing routine death surveillance as well as errors in MCCD. The combined correction factor could be higher than the upper range if errors in MCCD are higher than our assumptions.*

From *Adjusting Reported COVID_19 Deaths for prevailing Routine Death Surveillance in India* by Shewade et al (2021), Frontiers in Public Health. https://doi.org/10.3389/fpubh.2021.641991

Figure 4: Hausman test results (Model A)

```
. hausman fe re

Note: the rank of the differenced variance matrix (5) does not equal the
        number of coefficients being tested (6); be sure this is what you
        expect, or there may be problems computing the test.  Examine the
        output of your estimators for anything unexpected and possibly
        consider scaling your variables so that the coefficients are on a
        similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |      fe           re          Difference          S.E.
-------------+----------------------------------------------------------------
   mavg_pcte |   .0000332     1.27e-06         .000032         .0003109
   mavg_gsdp |  -6.78e-08     2.03e-10       -6.80e-08         3.30e-08
    mavg_pop |  -.0004348     7.68e-06       -.0004425         .0024609
mavg_agedpop |   .3113625     .0977736        .2135889         .6625793
 2021bn.year |    .172414     .0050611        .1673529         .1689173
   2022.year |  -.6958574    -1.037501        .3416432         .3511085
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        4.35
                Prob>chi2 =      0.5005
                (V_b-V_B is not positive definite)
```

Figure 5: Hausman test results (Model B)

```
Note: the rank of the differenced variance matrix (5) does not equal the number of
        coefficients being tested (6); be sure this is what you expect, or there may
        be problems computing the test.  Examine the output of your estimators for
        anything unexpected and possibly consider scaling your variables so that the
        coefficients are on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |      fe           re          Difference          S.E.
-------------+----------------------------------------------------------------
   mavg_pcte |   -.0001751     .0000131       -.0001881        .0000572
   mavg_gsdp |   -2.81e-09    -2.12e-10       -2.60e-09        6.14e-09
    mavg_pop |    .0002278    -5.55e-06        .0002334        .0004604
mavg_agedpop |    .0304909    -.0087033        .0391941         .123181
 2021bn.year |     .029079     .0034226        .0256564        .0293566
   2022.year |   -.0164941    -.0735089        .0570148        .0643271
------------------------------------------------------------------------------
                          b = consistent under Ho and Ha; obtained from xtreg
           B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       12.46
                Prob>chi2 =      0.0290
                (V_b-V_B is not positive definite)
```